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of Engineers**

Alaska District

RELOCATION PLANNING PROJECT MASTER PLAN

Kivalina, Alaska



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Relocation Planning Project

Master Plan

Kivalina, Alaska

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List of Acronyms/Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADOT&PF	Alaska Department of Transportation and Public Facilities
AE	Architect Engineer
AEA	Alaska Energy Authority
AIDEA	Alaska Industrial Development and Export Authority
ANA	Administration for Native Americans
ANCSA	Alaska Native Claims Settlement Act
ANTHC	Alaska Native Tribal Health Consortium
ARECA	Alaska's Electric Association
AS	Alaska Statutes
AVEC	Alaska Village Electric Cooperative, Inc.
BFRLF	Bulk Fuel Revolving Loan Fund
BIA	Bureau of Indian Affairs
Btu	British thermal unit
CBD	DCED Division of Community and Business Development
CCAP	Child Care Assistance Program
CES	Cooperative Extension Service
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers, Alaska District
CRREL	U.S. Army Cold Regions Research and Engineering Laboratory
CRUM	Cold Regions Utilities Monograph
CWA	Clean Water Act
DCED	Alaska Department of Community and Economic Development
DEHE	Department of Environmental Health and Engineering
DHHS	U.S. Department of Health and Human Services
DNR	Alaska Department of Natural Resources
DOI	U.S. Department of Interior
DPOR	DNR Division of Parks and Outdoor Recreation
EDA	U.S. Department of Commerce, Economic Development Administration
EDD	Economic Development Districts
EPA	U.S. Environmental Protection Agency
FNDI	First Nations Development Institute
ft	feet
gpd	gallons per day
gpd/person	gallons per day per person
gph	gallons per hour
gpm	gallons per minute
gpy	gallons per year
hrs/day	hours per day
Hp	horsepower
HUD	U.S. Department of Housing and Urban Development
IDIQ	Indefinite Delivery Indefinite Quantity

IHS	Indian Health Services
ISA	Indian Set-Aside
KRPC	Kivalina Relocation Planning Committee
kW	kilowatts
kWH	kilowatt-hours
kWH/yr	kilowatt-hours per year
kWH/yr/person	kilowatts-hours per year per person
lbs	pounds
mbh	million Btu's per hour
n/a	not applicable
n.d.	no date listed
NPS	U.S. Department of Interior, National Park Service
NRC	NANA Regional Corporation
NRCS	USDA Natural Resources Conservation Service, formerly Soil Conservation Service
NWABSD	Northwest Arctic Borough School District
O&M	operation and maintenance
ONAP	Office of Native American Programs
PCE	Power Cost Equalization
PL	Public Law
RD	Rural Development
RHED	Rural Housing and Economic Development
RUBA	Rural Utility Business Advisor
RUS	Rural Utility Service (Old Rural Electrification Administration)
RWST	raw water storage tank
SBA	Small Business Administration
SBDC	Small Business Development Center
SDS	Sanitation Deficiency System
SOP	Regional Facility Program & Sustained Operations Program
sq. ft.	square feet
SuperNOFA	Super Notice of Funding Availability
SWDA	Safe Drinking Water Act
TNH	Tryck Nyman Hayes, Inc.
TWST	Treated Water Storage Tank
UAA	University of Alaska Anchorage
UA/CED	University of Alaska Center for Economic Development
UAF	University of Alaska Fairbanks
URS	URS Corporation
U.S.	United States
USC	United States Code
USDA	U.S. Department of Agriculture
VSW	ADEC Village Safe Water
WHIP	Wildlife Habitat Incentives Program
WST	water storage tank
WTP	water treatment plant
WTVP	water treatment vacuum plant

1 INTRODUCTION

1.1 CORPS OF ENGINEERS STUDY AUTHORITY

The investigations documented in this report were conducted under the Tribal Partnership Program as defined in the Water Resources Development Act of 2000 (P.L. 106-541, Sec. 203) and the Planning Assistance to States (PAS) program, as authorized by Sec. 22 of the Water Resources Development Act of 1974 (P.L. 93-251) as amended. The Water Resources Development Act authorizes the Assistant Secretary of the Army for Civil Works (Secretary), acting through the Chief of Engineers to cooperate with States to prepare plans for the development, utilization, and conservation of water; and related land resources of drainage basins located within the boundaries of the State. Section 319 of the Water Resources Development Act of 1990 (Public Law 101-460) directs the Secretary to collect 50% of the cost of PAS projects from non-federal entities. Funds and direction for Kivalina relocation planning were also provided in the Consolidated Appropriations Resolution, 2003 (P.L. 108-7, Division D, conference report H.R. 108-10, page 807 and Senate report S.R. 107-22, page 23), and further direction was provided in the Energy and Water Development Appropriations Act, 2004, P.L. 108-137, conference report H.R. 108-357, Sec. 112. Local signatories of the PAS agreement are the City of Kivalina, the Native Village of Kivalina, and the Northwest Arctic Borough. The Alaska Native Tribal Health Consortium also provided local funds for the sanitary facilities portion of this scope.

Previous studies relating to Kivalina relocation are referenced within this document when applicable. At times, information in this document may conflict with previous Corps studies when new

information has become available. In such instances, the information in this document will be the most current and the most pertinent.

1.2 PURPOSE AND SCOPE

This master plan provides preliminary facility designs, costs, schedule, and a decision matrix for the community of Kivalina and its relocation stakeholders. This information is necessary to obtain funding for the village relocation and to begin designing the new town site. The master plan compiles information that allows a reasonable comparison between the eight (8) alternatives for relocation and develops a reasonable schedule of anticipated relocation activities.

This study includes six (6) new town sites, the “no action” option, and the option of making improvements at the existing site. Areas identified as possible locations for the new town site are:

- Simiq
- Imnakuk Bluffs
- Tatchim Isua
- Kiniktuuraq
- Igrugaivik
- Kuugruaq

In a community vote, Kivalina residents expressed a preference for Kiniktuuraq as the new town site. However, general comparisons of all alternative sites are included in this report.

Kiniktuuraq, Imnakuk Bluffs, Igrugaivik, and Kuugruaq were the subject of existing reports or supporting data, principally the 1994 Relocation Study, Kivalina Alaska by DOWL Engineers, and the 1998 Community Improvement Feasibility Report, Kivalina, Alaska by Alaska District Corps of Engineers. The scope of work for this report assumes that the existing information for

these four sites is adequate. Simiq and Tatchim Isua were to be investigated and brought up to the same level as the above-mentioned four alternatives.

See Figure 1 for a visual layout of the Kivalina Relocation Alternatives.

1.3 PREVIOUS STUDIES AND/OR REPORTS

Reports and studies reviewed and referenced for this report include:

1.3.1 U.S. Army Corps of Engineers Studies

- Tryck Nyman Hayes and URS Corporation (TNH/URS). Relocation Planning Project – Village Requirements Report; Building and Facilities Inventory Map; List of Stakeholders; Resource Identification Report – Kivalina, Alaska for the U.S. Army Corps of Engineers, Alaska District. October 2003.
- R&M Consultants. Phase II Engineering Services Geotechnical Investigation – Kivalina Town site Relocation for the U.S. Army Corps of Engineers, Alaska District. August 2002.
- Tryck Nyman Hayes and URS Corporation (TNH/URS). Kivalina Relocation Community Layout Plan for the U.S. Army Corps of Engineers, Alaska District. December 2001.
- R&M Consultants. *Reconnaissance Geotechnical Investigation – Kivalina Relocation* for the U.S. Army Corps of Engineers, Alaska District. January 2000.
- U.S. Army Corps of Engineers. *Community Improvement Feasibility Report*. Alaska District, April 1998.

- DOWL/BBFM Joint Venture. *Geotechnical Investigation – Kivalina Borrow Material Exploration* for the U.S. Army Corps of Engineers, Alaska District. December 1998.

1.3.2 Studies By Others

- ASCG Incorporated. *Kivalina Sanitary Survey*. May 2004.
- Golder Associates. *Geophysical Groundwater Source Investigation – Kivalina, Alaska*. October 1997.
- DOWL. *City of Kivalina Relocation Study*. December 14, 1994.
- CH2M Hill. *Water & Wastewater Feasibility Study*. January 1984.

1.4 PLANNING OBJECTIVES

The following planning goals and objectives have been established for the Master Planning Phase of the Kivalina Relocation Project:

GOAL: Assist the community of Kivalina in selecting the most feasible and appropriate alternative.

Objective: Work with the community to identify site evaluation criteria that consider: safety, construction and operations costs, and social and cultural needs.

GOAL: Plan for efficient and orderly relocation of Kivalina.

Objective: Identify specific phases of planning, design, permitting, construction, and moving associated with the relocation of Kivalina.

Objective: Develop a preliminary schedule for the phases of relocation.

Objective: Review phasing considerations and the preliminary schedule with potential local, state and federal partners and the community of Kivalina.

GOAL: Initiate conceptual engineering for utilities and other infrastructures for relocation sites under consideration.

Objective: Develop engineering concepts that can be used for each of the sites under considerations for relocation.

Objective: Evaluate each of the sites under consideration for relocation with regard to conceptual engineering.

1.5 PROBLEMS AND OPPORTUNITIES

Many of the problems that Kivalina faces are a result of erosion and flooding. The potential threats from erosion and flooding have inhibited investment in the community, whether it is improving water supply and distribution, sewage treatment, transportation systems, or providing adequate housing. The combination of erosion and flooding threats, combined with inability to invest in community

improvements and lack of community expansion opportunities at the existing site results in the need for community relocation.

1.5.1 Erosion, Flooding, and Global Warming

For nearly two decades, local residents have been concerned with the threat that coastal erosion and storm surge poses to the community of Kivalina. Review of aerial photos since the 1980's indicate that there has been a loss of the width of beach from the mouth of the Wulik River north towards the airport, with a rapid increase in erosion into specific upland areas of the community over the last 5 years. The potential loss of the town site to the encroaching sea provides ample justification for its relocation. Moreover, there is no reason to believe that this trend will cease in light of the global forces that appear to be contributing to it. While causes of global warming are a matter for scientific debate, it is an indisputable fact



This 1983 photo of Kivalina shows the distance between the village school (the large brown building to the left of center) and the shoreline. The shoreline has now eroded so that the shoreline is a few feet from the school.

that climates are changing over most of the planet, and that some of these changes are most evident in the Arctic (e.g. Houghton 1997, Easterling et al. 2000).

Without addressing global scale effects on the Arctic climate, it is sufficient to note that some of the end effects have potentially dire consequences for Kivalina and other villages located on or near Arctic Ocean shorelines. First, the steady diminution of the Arctic Ocean ice pack (Linacre & Geerts 2004) enhances the potential for increased coastal erosion in at least two ways :

- Since the early 1980s the time between spring break-up of land fast sea ice and autumn freeze-up along Arctic shorelines has increased from barely three months to as much as five months. Longer periods of ice free water extend the “season” for coastal erosion.
- Larger expanses of ice-free water provide longer fetches over which winds can generate ocean waves that are higher, longer, and thus potentially more destructive to the shorelines where they ultimately dissipate their energy.

A short-term implication of these facts is that the present town site will require coastal erosion protection until relocation is completed. As already noted in Section 2.1.5, statistics indicate that the interval of occurrence for a 4-ft elevation storm surge, as occurred on 20 October 2004, is once a year. According to Wise et al. (1981), a 6-ft storm surge would have a recurrence interval of less than 5 years. The approximate island height of 10 feet would indicate that a 6 ft storm would result in 6 inches of water covering the community. Preliminary modeling by the Engineering Research Design Centre (ERDC) indicates that the 100-year storm surge event would have a water surface of 3.2 meters (10.5

feet) *with no ice cover*. The status of ice cover during a storm surge event will play a major role in determining how much flooding could occur.

A 2003 working draft report prepared for the Alaska District Corps of Engineers (D. Mark 2003) that re-evaluated storm surge threat to the existing site of Kivalina states that “preferred site for community relocation is subject to storm surge from the Chukchi Sea.” While it does not name Kinikturaq specifically, it likely refers to that site. The revised evaluation of storm surge indicates that existing 1970 storm of record resulted in a 13.57 foot surge that inundated portions of the existing site. Results of modeling calculated that the 50 year occurrence storm surge would reach an elevation of 13.5 feet and the 100 year occurrence storm surge would reach an elevation of 16.1 feet.

It is important to recognize that there is a 70% chance that an event with a 5 year recurrence interval will occur during the five-year period that will be required for relocation of Kivalina. There is better than a 50% chance of seeing a 6 foot storm surge before the relocation is completed; some provisions should be made to prepare for that occurrence.

Other consequences of global warming that are relevant to the selection of a new town site include sea level rise (EPA 2004) and permafrost degradation (Arctic Climate Project 2004). Implications of the former would include rejection of low-lying sites, even though they are considered to be a “safe” distance from the coast. While the amount of sea level rise that will be seen in Alaska is not yet determinable, it is projected to be as much as 1-2 feet over the next 100 years in more temperate locations. Permafrost degradation can result in lowering the elevation of the surface elevation and increasing the rates of erosion of ice rich soils along the coast. This in turn

could increase the extent of storm surge inundation and site stability for construction of buildings and infrastructure.

Relocating the Kivalina town site to an inland area would alleviate concerns regarding potential island site flooding as well as providing relief from shoreline erosion. The new project site could be designed in such a way that impacts from future permafrost degradation are minimal.

1.5.2 Water Supply and Distribution

The present water supply and distribution system presents two major problems: storage tanks cannot be replenished for approximately three months out of the year while the Wulik River is frozen, and the majority of the community does not have a piped water supply. In addition, the water transmission lines are not heated, Water cannot be pumped when temperatures are below freezing. The total storage volume of approximately 1,200,000 gallons is minimal for current community needs as well as inadequate for fire fighting capabilities. The stored water occasionally runs low before the tanks can be replenished. During these times, public access to the watering point is halted and the treated water is reserved for the school. Mr. Enoch Adams Jr., Chair of the KRPC, indicated that since 1986 both community water tanks have run low five times, even with residents collecting water from other sources (TNH/URS, 2003).

Even though community water is usually available, the treated water has an unpleasant taste. Because some Kivalina residents do not like the taste of the treated water, they rely on several other sources including: 1) rainwater collection by roof catchments, 2) individual collection of water up the Kivalina River in the summer, and 3) blocks of river ice cut in the winter. Some residents employ a Brita filter in their homes to further treat the water and improve the taste. Residents also purchase distilled

water at the store. Because of the lack of piped water, the upgrade of the current water supply system in Kivalina is a high health and safety priority of the community.

However, federal and state agencies will not support installation of a piped water system in Kivalina given the threat from flooding and erosion. The village cannot upgrade to a piped water supply system without moving to a new town site. Moving the town site to an area with an adequately sustainable, year-round water source that can provide for a piped water system would meet the community's sanitation needs.

1.5.3 Waste Disposal

1.5.3.1 Human Waste

The necessary distance from the community to the honey bucket bunker creates a potential hazard. The community must transport their honey buckets by four-wheeler trailers or snow machine sleds, which may result in spills that would be a threat to human health. Individual residences must manage their own septic waste, which is an unpleasant chore at best and a health hazard at worst.

The upgrade of the current sewer system in Kivalina is a top priority to the health and safety of the community. However, federal and state agencies will not support installation of a piped sewer system in Kivalina given the threat from flooding and erosion. When the village is relocated, a new piped sewage collection and disposal system could be installed. A piped system will greatly reduce hazardous spills and allow for a generally higher level of health and sanitation.

1.5.3.2 Solid Waste

Located near the honey bucket dump is a landfill-type garbage disposal facility. The landfill is located too close to the runway, in violation of the airstrip set back limits. This

close proximity to the runway creates a hazard to aircraft when scavenging birds are attracted to the landfill. Bird strikes are extremely dangerous to aircraft and can quite easily cause an airplane to crash.

Both the current landfill and an older dumpsite (just north of the airstrip) have numerous hazards, including blowing trash, the potential for contamination of surface waters, and the creation of an attractant for nuisance wildlife in close proximity to the airport. Lack of cover material is also a problem. Kivalina has no centralized or coordinated collection or control system in place. No record of waste taken to the landfill has ever been kept, and it is not known whether hazardous waste is separated from municipal solid waste. The distance from the community and transport of garbage by four-wheel vehicle results in spilled garbage that can spread across the island and even into the Chukchi Sea and Kivalina Lagoon. Kivalina residents are not in compliance with ADEC regulations pertaining to the collection of solid wastes.

Relocating the town site will offer an opportunity to replace the current system. Replacing the current disposal facility would address ongoing critical safety and health issues, and provide an improvement to the collection process.

1.5.4 Transportation

Severe weather and increased storm surges affect transportation in Kivalina. Since there are no roads in and out of Kivalina, the community relies solely on supplies delivered by air and by barge.

Air service is available to the village throughout the year, however, inclement weather often prevents air travel during the winter. Airplanes bringing in supplies are often unable to land in severe weather. Recently, the airport has been threatened by erosion from storm damage. Air

transportation is also very expensive, which for some residents means that air travel is cost prohibitive.

Crowley Marine Services makes two annual barge trips to Kivalina to deliver fuel and other supplies. Barges set sail to Kivalina from Kotzebue. Crowley attempts to run the trips back-to-back to take advantage of good weather, usually in July or August. Actual trip dates are weather dependent, as barge operators must take into account wind, swells, and general weather conditions. Erosion in the existing community is creating difficulties for barge landings.

Surface transportation difficulties have also emerged due to warming trends. Increasingly warmer temperatures have caused ice to retreat and have made it more difficult to travel across the ice in the winter. Hindrance in transportation highly affects subsistence activities, which are necessary for survival for the community.

While relocating the village to a new town site in the area will not solve the region's air transportation limitations, interruptions in transportation due to storm surges, swells, and erosion can be avoided at a different town site. A new town site on the mainland will also eliminate the necessity of traveling over the ice in the winter, greatly reducing the impact of retreating ice cover on surface transportation.

1.5.5 Housing

Problems associated with the housing at the existing community site include a limited number of houses, the poor condition of the existing housing, overcrowding, the lack of water and sewer connections, and potential flooding and erosion damage to existing housing. The potential threats to housing from flooding erosion and limited area for constructing new housing are major obstacles to improving the supply and quality of housing at the existing site.

Overcrowded housing lacking running water and sewer connections results in increased health risks. Funding for water and sewer to houses has been hindered due to erosion and relocation issues. The inability to expand has forced residents into overcrowded situations and hindered development.

Flooding and erosion have already forced the relocation of houses due to danger from storm surges. As the beach erodes, the amount of land decreases and residents are forced to move houses even closer together.

An opportunity exists to relocate Kivalina to a new site that would not be susceptible to flooding, erosion, or storm surge. A new town site would allow for additional homes to be built, relieving the overcrowding. Lastly, the construction of new homes would have stricter standards for energy efficiency than the existing homes. With heating costs a substantial portion of household budgets, new home construction could offer a financial savings to the occupants.

1.5.6 Social Conditions

Overcrowding, lack of infrastructure, loss of traditional cultural knowledge, and poor living conditions in general have created difficult social conditions. Residents indicate that people have moved out of the community due to the limited housing and lack of sewer and water. Kivalina residents have pursued the possibility of relocating the village for the last two decades. Residents have been tenacious and determined to see the project to fruition, however because the process has taken so long, residents have recently expressed concern over whether relocation will happen in the foreseeable future or at all. The difficult living conditions combined with feelings of hopelessness could greatly contribute to social problems in the village.

1.6 PLAN FORMULATION

The Water Resources Act of 1965 requires that the Corps of Engineers use planning principles in the formulation and evaluation of water and water-related land resources implementation studies associated with their Civil Works projects. The Corps planning model selects the best plan by identifying problems and opportunities, inventorying and forecasting alternatives, formulating alternative plans, evaluating plan effects, and comparing the effects of alternative plans.

Alternative plans must be formulated to address the problems identified by the planning objectives. Each alternative plan is evaluated according to four criteria: completeness, effectiveness, efficiency, and acceptability.

Figure 1 shows the possible relocation sites that were investigated for potential use as a new Kivalina town site over the last ten years. These sites were not fully evaluated due to a lack of adequate site geotechnical investigations. This deficiency was evidenced when geotechnical investigation revealed ice-rich soils in a seemingly favorable site, eliminating that site from future consideration. The community then chose Kiniktuuraq as the preferred site through a referendum during a recent municipal election. Since that selection, recent and severe fall storms confirmed that Kiniktuuraq is subject to coastal storm surge flooding and ice override. A 2004 site visit revealed that the site contains ice-rich soils, presenting significant site development constraints.

1.6.1 Formulation Approach and Methodology

The methodology for plan formulation involves identifying alternatives to a proposed action and developing each alternative to a comparable level. A “no

action” alternative is included to access the consequences of taking no action and to allow for a complete comparison of alternatives. Eight alternatives, including the “no action,” are presented in Section 3 of this report and are described in detail. Evaluation criteria are described in Section 1.6.2. A decision matrix (Appendix D) was designed to focus the site selection discussions into an easily comprehensible format including physical environment factors; construction and utilities requirements, social and access concerns and cost implications.

This plan re-evaluates the six previously identified town sites, the “no action” alternative, and the option of making improvements to the existing town site. Recent climate trends in northwest Alaska indicate an increase in the occurrence of severe storm flooding, accelerated erosion, and melting and subsidence of ice-rich soils. These trends indicate a need for adequate field studies and evaluation of long-term site stability. The potentially high cost of community relocation requires thorough evaluation of all alternatives.

1.6.2 Evaluation Criteria

The criteria for evaluating each site were developed to identify the risks and benefits associated with each alternative (see Appendix D).

Specific criteria were developed under four broad categories: physical environment factors; construction and utilities requirements; social characteristics and site access concerns; and cost implications:

- **Physical environment** factors refer to the sites’ vulnerability to physical processes such as storm surges, riverine flooding, erosion, and high winds; other environmental factors such as site drainage, wetlands, ice-rich soils, and climate.

- **Construction and utilities criteria** assess factors associated with the feasibility of site construction including the development of cost efficient utility services. The primary construction factors include gravel requirements to develop the site and availability of gravel sources; ease of maintaining two sites during construction; potential for community expansion; and permitting obstacles. The primary utility factors include availability/suitability of community water source; sewage disposal; ease of water supply, storage, and distribution; availability/suitability of solid waste disposal; barge access and distance to the site; and site for an airport with proper wind configuration.
- **Social and access criteria** evaluate site characteristics that are important in terms of subsistence and other traditional activities. Factors identified include distance from the current village site; access to the ocean, Wulik River, Kivalina river, and Kivalina Lagoon (for travel and subsistence activities); access to subsistence camps and traditional use areas; location and size of boat and gear storage areas; potential for ice cellar construction; and general social acceptance of the site.
- **Cost implications criteria** assess relative construction and operational expenses associated with various sites. Factors include site preparation costs; road development costs; operation and maintenance costs; cost of living for housing and utilities; and cost of fuel for access to subsistence areas, the airport, and dock.

- Preliminary site evaluation criteria were presented to the community of Kivalina during the December 7, 2004 meeting, and initial feedback was received and incorporated into the criteria. On September 15, 2005, a meeting was held with the Kivalina Elders Council to ask more specific questions regarding each of the alternative relocation sites. The results of this meeting were incorporated into evaluation of sites and ranking criteria.